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Virtual reality disaster training: Translation to practice

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ABSTRACT

Disaster training is crucial to the mitigation of both mortality and morbidity associated with disasters. Just as clinical practice needs to be grounded in evidence, effective disaster education is dependent upon the development and use of andragogic and pedagogic evidence. Educational research findings must be transformed into useable education strategies. Virtual reality simulation is a teaching methodology that has the potential to be a powerful educational tool. The purpose of this article is to translate research findings related to the use of virtual reality simulation in disaster training into education practice. The Ace Star Model serves as a valuable framework to translate the VRS teaching methodology and improve disaster training of healthcare professionals. Using the Ace Star Model as a framework to put evidence into practice, strategies for implementing a virtual reality simulation are addressed. Practice guidelines, implementation recommendations, integration to practice and evaluation are discussed. It is imperative that health educators provide more exemplars of how research evidence can be moved through the various stages of the model to advance practice and sustain learning outcomes.

The future of nursing in today's world requires an examination of how we educate and what content we impart to nurses (Benner et al., 2010). Just as clinical practice needs to be grounded in evidence, effective nursing education is dependent upon the development and use of andragogic and pedagogic evidence (Institute of Medicine, 2010). Educational research findings must be transformed into useable education strategies. There is a need for nursing education strategies that engage students in critical thinking while allowing practice in safe environments. Opportunities to train for some health-related events are severely limited. For example, mass casualty incidents occur infrequently in any given location, but practice is needed to prepare a well-trained healthcare team to respond to these disasters. One innovative teaching intervention is virtual reality simulation (VRS). The purpose of this paper is to describe the translation of a VRS research study findings into nursing education practice focusing on disaster preparation.

The Ace Star Model is a conceptual framework set forth to systematically put evidence-based practice processes into operation (Stevens, 2004). The model identifies five key stages to transform knowledge (i.e. research) into practice. The first stage is that of knowledge discovery. Using scientific inquiry, both new qualitative and quantitative knowledge is discovered. In stage two, evidence is summarized into a meaningful statement. The third stage results in the development of practice guidelines and recommendations. The fourth stage of the model includes the integration of the strategy into practice. In the final stage outcomes are evaluated (Stevens, 2004). This model will be applied to a study of VRS in disaster training and translation of the teaching method to nursing education practice.

Background and significance

Federally declared disasters occur at a rate of approximately one per week across the United States (Federal Emergency Management Agency, 2011). As a result, there is an ongoing need to improve the education of healthcare workers training for disaster response (Chapman and Arbon, 2008; Spleski and Littleton-Kerney, 2010). Preparation for disasters may be hindered by limited access to disaster training opportunities; live disaster drills are costly and difficult to coordinate. An alternative method to train responders is to simulate such disasters with VRS (Heinrichs et al., 2010). *Virtual Reality* is a broad term encompassing a wide range of technology (Blade and Padgett, 2002), which can vary from desktop computer simulations to head-mounted displays with sophisticated motion tracking to spatialized audio systems to

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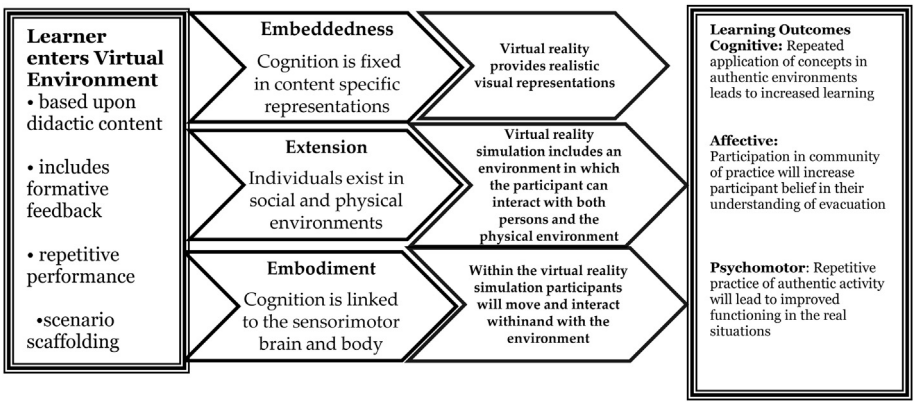
multi-wall 3D projection systems like a CAVE (Cave Automatic Virtual Environment) (Strangman et al., 2003). While the technology varies, the common theme of VRS is to provide a human–computer interface that simulates an alternate three-dimensional environment and presents multisensory stimulation to the user (e.g., some combination of visual, auditory, haptic, olfactory, proprioceptive, inertial, etc.) and allows the user to interact with the synthetic environment in real time (Stanney and Cohn, 2009; Stanney and Zyda, 2002). In the present work, VRS refers to an interactive desktop computer simulation, which is preferred for its low cost, wide accessibility and ability to embed such simulations with a website for distribution. The same learning principles could be applied to other types of specialized VRS.

Defining terms is important to understanding the nature of emergency and disaster response. Common terms for these emergent situations include *emergency, disaster*, *crises* and *critical incidents*. Emergencies, crises and critical incidents are often used interchangeably and refer to sudden and usually unforeseen events that require immediate action by a local agency or industry to minimize consequences. These occurrences include adverse events that do not have community wide impact or do not require extraordinary use of resources or procedures to bring conditions back to normal (Blanchard, 2008). For example, a power outage at a local hospital would be a critical incident. The event calls for immediate action by the agency, but does not usually require outside resources or disrupt the community at large. Disasters occur on larger scales and require resources beyond the local response. Examples include State or Federal response, multiple agency involvement, and former declarations by government officials. A disaster may be a manmade or natural event. Occurring with or without warning and resulting in damages these events exceed the local capacity to respond and external assistance. Examples of these events include earthquakes, tsunamis, landslides, hurricanes, tornadoes and wild fires. Damages may include environmental damage, human casualties and result in mass disruption of society (Center for Disease Control and Prevention, 2012).

Theoretical framework

The use of VRS as an education method is grounded in the theory of situated cognition. Learners must apply and practice in realistic environments. The theory is based upon concepts of embodiment (cognition is dependent on the sensorimotor brain and body), embeddedness (cognition is fixed in context specific representations) and extension (cognitive systems exist in a physical and social environment) (Brown et al., 1989). The sense of self-location, the sense of agency, and the sense of body ownership are critical to learning (Gallagher, 2005; Mallot and Basten, 2009). Meaningful learning will only take place if it is set in the culture of the situation in which is it is intended to be used. Educational technology, through virtual reality and interactive multimedia, is supported as an avenue to bring situated learning into the classroom (Harley, 1993). According to Herrington and Oliver (1995), within the framework of situated cognition virtual simulations provide a learning opportunity that has the critical characteristics of a traditional apprenticeship. Interactivity is a key to learning (Herrington and Oliver, 1995; Hansen, 2008; Hannafin and Hannafin, 2010). Moreover, situated cognition fosters the expansion of individual cognitive knowledge along with social and physical interactions thus facilitating cognitive, affective and psychomotor learning (Hansen, 2008; Hannafin and Hannafin, 2010). Below is a visual representation of situation cognition applied to VRS.

Situated cognition



The Ace Star Model

Point 1: discovery

In a longitudinal study using an experimental design, the effects of disaster training with and without VRS were explored (Farra et al., 2013). The subjects of the study, Associate Degree nursing students in their second year, participated in disaster training using web-based models. The control group used the web-based modules alone while the treatment group completed the web-based modules along with a VRS to reinforce content. Learning and retention were measured using a 20 question multiple-choice test. Content validity of the tool was accomplished through review by both disaster and education experts. Reliability of the assessment was determined by test-retest consistency ($r = .72$). Three measurement points were assessed pre-training, immediately post-training, and two months following training.

The results of the assessments were analyzed using the generalized linear model and general estimating equations with overall effect of the VRS was found to be strongly significant ($p < .0001$). The post knowledge scores, and 2-month knowledge scores were significantly different ($p < .0001$) with an effect size of $d = -.676$. Although the two groups varied significantly on the immediate posttest, differences were even greater between the groups at two months ($p < .0001$), indicating greater retention of disaster training content in the RS group. The control group that did not receive the